

Clearance Standards for the Barclay Street Property

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1 Introduction

The property at 300 South Barclay Street and 139 East Oregon Street, Milwaukee, Wisconsin includes several former industrial buildings that will be redeveloped for residential use. Gradient developed dust clearance standards for wipe samples and for bulk dust samples, to be used in determining whether building surfaces are sufficiently clean or sealed for residential use. These clearance standards may be used after cleaning, sealing, or encapsulation of interior building surfaces (*e.g.*, walls, floors, or columns), as well as to support activities that will be part of a future Operations & Maintenance (O&M) plan.

2 Compounds of Potential Concern (COPCs)

Samples of building materials collected at the Barclay Street Property included a total of 25 samples collected from Buildings 11, 33, and 34. Building materials sampled included brick walls, concrete floors, walls, columns, tile ceilings, and wood ceilings. Samples were analyzed for metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). Detected analytes included 28 metals, cyanide, 2 PCBs, 35 SVOCs, and 21 VOCs.

Gradient conducted a screening analysis of the sample data to determine the list of compounds of potential concern (COPCs) for which interior dust clearance standards would be developed. The screening criteria were the US Environmental Protection Agency (US EPA) Regional Screening Levels (RSLs) for residential soil. (US EPA has not published an RSL for titanium, thus the screening value for titanium was obtained from California EPA [CalEPA] [CalDTSC, 2013].) The RSLs were those with noncancer hazard calculated with a target hazard quotient (HQ) of 0.1, and cancer risk calculated with a target risk of 1×10^{-6} (US EPA, 2017a). Compounds were retained as COPCs if the maximum detected concentration was greater than the RSL. A total of 24 analytes were retained as COPCs, including 15 metals, cyanide, 2 PCBs, and 6 SVOCs.

Table 1 lists the COPCs and the maximum exceedance ratio for each combination of building and surface sampled. The maximum exceedance ratio is equal to the maximum detected concentration divided by the RSL. This table illustrates the relative frequency of exceedances across various buildings and surfaces. Metals and PCBs are fairly widespread, with the highest concentrations in Building 11. The SVOC exceedances are less widespread, with exceedances of the RSL in only one or two building/surface combinations. Interior dust clearance standards were developed for this list of 24 COPCs. There are no VOCs on the COPC list, because all of the VOC concentrations as measured in the building material bulk samples were below their respective RSLs.

3 Evaluation of Analytes with Elevated Detection Limits

In addition to the analysis described above to support the development of the COPC list, Gradient also evaluated analytes that were not detected, based on their detection limits. When a detection limit exceeds the screening criterion, it is not possible to rule out the presence of that analyte at a concentration that would place it on the COPC list. It should be noted that detection limits in some samples were elevated because samples were diluted prior to analysis in order to bring concentrations of target analytes to within the calibration range of the analytical method. The lab also reported that some samples were diluted "due to the nature of the sample matrix" (TestAmerica Laboratories, Inc., 2017).

This analysis was done by comparing detection limits to the screening criteria, and noting the number of samples where the detection limit exceeded the criterion. A total of 35 analytes had detection limits above the screening criteria based on an HQ of 0.1; of these, 8 had at least one detect, and 27 had no detects

(Table 2). Five of the analytes (hexavalent chromium, PCB-1254, PCB-1260, bis(2-chloroethyl)ether, and N-nitrosodi-n-propylamine) were already identified as COPCs in the initial screening; *i.e.*, they had a detectable concentration exceeding the screening criteria. Because the majority of the analytes in this list (other than those already on the COPC list) were not detected in any samples, and thus cumulative health effects for these analytes may not be a concern,¹ and to better determine the extent to which elevated detection limits might pose a concern, we also compared the detection limits to RSLs based on an HQ of 1; a total of 31 analytes had detection limits above these screening criteria (Table 2). These analytes are discussed further below, grouped as metals, PCBs, polycyclic aromatic hydrocarbons (PAHs), non-PAH SVOCs, and VOCs.

- **Metals:** Hexavalent chromium was already included on the COPC list (Table 1) and is not discussed further. Typical method detection limits for thallium exceed the screening criterion based on an HQ of 0.1. However, no samples have detection limits exceeding the RSL based on an HQ of 1. Therefore, Gradient does not recommend adding thallium to the COPC list.
- **PCBs:** Aroclors 1254 and 1260 were already included on the COPC list (Table 1). Five additional PCB Aroclors have elevated detection limits in samples where Aroclor 1254 was found at high concentrations. The inclusion of Aroclor 1254 on the COPC list will result in post-cleaning analysis of all PCB Aroclors, thus Gradient does not believe there is value in including additional PCB Aroclors on the COPC list.
- **PAHs:** Two PAHs (benzo[a]pyrene, and dibenz[a,h]anthracene) have detection limits above the screening criterion. The highest detection limits for benzo[a]pyrene and dibenz[a,h]anthracene occur in the Building 33, second floor wood ceiling sample (discussed further below). Because of these limited exceedances Gradient does not recommend adding PAHs to the COPC list.
- **Non-PAH SVOCs:** 13 additional SVOCs (10 with no detects) have detection limits in some samples that exceed the screening criteria. Two analytes with detects (bis(2-chloroethyl)ether and n-nitrosodi-n-propylamine) were already identified as a COPC in the initial screening. Of the 11 that are not already identified as COPCs, those with the highest number of detection limit exceedances (comparing to RSLs based on an HI of 1) include 2,6-dinitrotoluene, hexachlorocyclopentadiene, and pentachlorophenol. Several analytes have the highest detection limits in the Building 33, second floor wood ceiling sample. This sample also contains a significantly elevated detected concentration of bis(2-chloroethyl)ether (a solvent, also used as a component of paint and varnish). According to the City of Milwaukee Assessor website, Building 33 was constructed in 1928 (Milwaukee, 2017). Pentachlorophenol was first used in the United States in 1936 as a wood preservative (NTP, 2016), thus the wood used in building construction was not likely to have been preserved with pentachlorophenol. Therefore, Gradient does not recommend adding pentachlorophenol to the COPC list. Gradient does not recommend adding 2,6-dinitrotoluene or hexachlorocyclopentadiene to the COPC list as long as they are included as analytes in the air sampling plan (see Section 4).
- **VOCs:** 11 VOCs have detection limits in some samples that exceed the RSLs based on an HI of 0.1. Only bromomethane was detected in a sample, and at a concentration below the screening criterion. No samples of bromomethane or 1,1,2-trichloroethane have detection limits exceeding the RSL based on an HQ of 1. Only 1,2,3-trichloropropane and 1,2-dibromo-3-chloropropane have detection limits in all 25 samples that are above the screening criteria based on an HQ of 1. For most samples, this is because the RSLs are lower than achievable detection limits. However, the Building 11 first floor concrete column sample was diluted 1,000-fold for analysis, and resulted in the highest detection limits for these analytes. This sample had elevated methyl acetate, a solvent

¹ The potential for cumulative health effects due to the presence of multiple chemicals with concentrations somewhat below an RSL based on an HI of 1 is the primary reason for performing screening with an RSL based on an HI of 0.1.

commonly used in paints (the maximum concentration was not higher than its screening criterion, so it is not considered a COPC). 1,2,3-trichloropropane is a paint and varnish remover. Thus, we cannot rule out concentrations of some VOCs above screening criteria, even though they have not been detected.

4 Volatile Organic Compounds

No VOCs were detected in the building material bulk samples at concentrations exceeding the screening criteria, thus VOCs were not retained as COPCs, and dust clearance standards were not developed for VOCs. However, a total of 21 VOCs were detected in the building material samples at concentrations below the screening criteria, and Section 3 notes that several VOCs had detection limits that were elevated above screening criteria (Table 2). Bulk building material samples are an insensitive measure of whether VOCs may pose an unacceptable exposure *via* the inhalation pathway. Thus, it is our understanding that a separate plan will be developed to determine the extent to which off-gassing of VOCs (and select SVOCs discussed in Section 3) from building materials is occurring. (Table 3 lists the number of VOC detects for each building/surface combination. VOCs detected the most frequently included methyl acetate, naphthalene, toluene, and xylenes. The wood ceiling in Building 33 had the highest number of detected VOCs. Table 4 lists the maximum VOC concentration detected for each building/surface combination. Methyl acetate and xylenes had the highest detected concentrations.)

5 Development of Clearance Standards

Gradient developed clearance standards for the analytes identified as COPCs in the evaluation above. The 24 COPCs included metals, PCBs, and SVOCs. Two types of clearance standards were developed for use in assessing interior dust samples that may contain degraded building materials; one for COPCs in surface dust loading (in $\mu\text{g}/\text{m}^2$) for use with wipe samples, and one for COPCs in bulk dust (in mg/kg).

Post-remedy dust data will be compared with these health-based clearance standards to verify that cleaning and sealing of building surfaces at the Barclay Street Property are adequately protective for future residential use. Surfaces, or bulk dust samples, with concentrations below their respective clearance standard indicate that concentrations in the samples are not anticipated to pose adverse health effects for future residents who may contact these surfaces.

6 Wipe Clearance Standards

Wipe clearance standards were calculated for all COPCs except for lead and PCBs. Lead has published clearance standards for residential settings. US EPA has established a dust lead clearance standard of $40 \mu\text{g}/\text{ft}^2$ ($431 \mu\text{g}/\text{m}^2$) for carpeted or uncarpeted floors in residences (US EPA, 2001). In general, lead risks are evaluated based on blood lead modeling. The floor dust standard was set with the goal that there should be no more than a 5% probability of a child having a blood lead level (BLL) greater than 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$) (US EPA, 2001).

PCBs are regulated under the Toxic Substances Control Act (TSCA), and the wipe standards used for PCBs are published in 40 CFR Part 761 (US EPA, 2016). The wipe standards for non-porous surfaces are $10 \mu\text{g}/100 \text{ cm}^2$ ($1,000 \mu\text{g}/\text{m}^2$) in high occupancy areas, and $100 \mu\text{g}/100 \text{ cm}^2$ ($10,000 \mu\text{g}/\text{m}^2$) in low

occupancy areas.² While there are no PCB wipe standards for porous surfaces, the wipe standards for non-porous surfaces will apply to the surfaces that were sealed with an encapsulant during redevelopment.

6.1 Selection of Methodology

US EPA does not have a recommended approach for calculating clearance standards. Gradient reviewed available methods for calculating dust wipe clearance standards, including the methods below:

- Florida Department of Health (FLDOH) method used for a Superfund Site (ATSDR and FLDOH, 2013);
- US EPA Office of Pesticides Program (OPP) method for residential exposures (US EPA, 2012);
- US Consumer Product Safety Commission (US CPSC) method for evaluating exposure to dislodgeable residues on treated wood surfaces (US CPSC, 1990);
- CalEPA risk evaluation of surfaces contaminated with metals (DiBiasio and Klein, 2003); and
- US EPA method used for calculating World Trade Center (WTC) benchmarks (US EPA, 2003).

All the methods rely on estimating a dose from hand-to-mouth contact based on COPC loading (mass of contaminant per surface area). While OPP methods are the most current, they incorporate fate and transport characteristics that are specific to pesticides and their applications (US EPA, 2012). ATSDR and FLDOH (2013) and US CPSC (1990) do not incorporate exposure from dermal contact *via* dermal absorption. CalEPA's method is based on exposure only to hard surfaces (DiBiasio and Klein, 2003).

Ultimately, the health-based clearance standards were developed using the methodology used by US EPA to calculate the World Trade Center (WTC) health based benchmarks for dust in residences (US EPA, 2003). We relied on this methodology because 1) it was the most comprehensive method incorporating all pertinent exposures (*e.g.*, dermal contact and hand-to-mouth contact, hard and soft surfaces), 2) it was developed and used by US EPA to determine possible site re-entry, and 3) it was used to calculate clearance standards for both metals and organics.

6.2 Exposure Pathways

The wipe clearance standards developed here account for two pathways of exposure to dust on indoor surfaces: "dermal contact" (*i.e.*, dermal absorption) and "hand-to-mouth" (*i.e.*, ingestion). The dermal contact pathway assumes that a person contacts dust on the building surfaces and constituents in the dust are absorbed through the skin (*i.e.*, dermal absorption). The "hand-to-mouth" (HtM) pathway assumes that a person gets dust on their hands by touching building surfaces, and then incidentally ingests some of that dust through hand-to-mouth contact. The clearance standard combines both pathways as described below.

² High occupancy areas are defined as occupancy ≥ 840 hours/year (an average of 16.8 hours or more per week) for non-porous surfaces and ≥ 335 hours/year (an average of 6.7 hours or more per week) for bulk PCB remediation waste (*i.e.*, porous surfaces) (US EPA, 2016). Examples include a residence, school, day care center, school class room, cafeteria in an industrial facility. Low occupancy areas are defined as occupancy less than 840 hours/year (an average of 16.8 hours or more per week) for non-porous surfaces and less than 335 hours/year (an average of 6.7 hours or more per week) for bulk PCB remediation waste (US EPA, 2016). Examples include locations in an industrial facility where a worker spends small amounts of time (such as an unoccupied area outside a building, an electrical equipment vault, or in the non-office space in a warehouse where occupancy is transitory) (US EPA, 2016).

6.3 Calculation of Wipe Clearance Standards

First, clearance screening levels (CSLs) are calculated for the dermal (CSL_{derm}) and HtM (CSL_{HtM}) pathways individually. Then, the final clearance standard is calculated as the inverse of the sum of the CSLs calculated for the individual pathways as shown below.

$$\text{Clearance Standard (mg/cm}^2\text{)} = \frac{1}{\frac{1}{CSL_{derm}} + \frac{1}{CSL_{HtM}}}$$

For COPCs with both cancer and noncancer effects, clearance standards were calculated separately for cancer and noncancer endpoints and the lower of the two clearance standards was used.

The calculations assume residents are exposed to dust on both hard and soft surfaces (*e.g.*, bare floors and carpets). Indoor surface exposures are assumed to be for 30 years, what US EPA assumed to represent the upper estimate for an individual residing at one residence for the WTC benchmarks (US EPA, 2003). Similar to the WTC benchmark approach, we assumed contact with indoor surfaces begins at age 1 year, when the child becomes mobile, and ends at age 31.³ Following on US EPA guidance, clearance standards based on cancer endpoints were evaluated for a 30-year exposure for a child and adult combined. Clearance standards for noncancer endpoints were calculated separately for a child (1-6 years) and adult (7-31 years) resident (US EPA, 1989).

6.3.1 Dermal Contact

The CSL_{derm} was calculated separately for cancer and noncancer endpoints using the following equations. The individual parameters and the basis for these parameters are discussed below.

Cancer endpoints:

$$CSL_{derm} = \frac{TCR \times AT}{(CSF_{derm} \times ABS_d \times DF)}$$

Noncancer endpoints:

$$CSL_{derm} = \frac{THQ \times AT \times RfD_{derm}}{ABS_d \times DF}$$

where:

$$DF = \sum_{age} \frac{\left[\left(TC_{h-age} \times ET_{h-age} \times \frac{FTSS_h}{2} \right) + \left(TC_{s-age} \times ET_{s-age} \times \frac{FTSS_s}{2} \right) \right] \times ED_{age}}{BW_{age}}$$

where:

$$CSL_{derm} = \text{Clearance Screening level for dermal pathway (mg/cm}^2\text{)}$$

³ Age 1 to 31 years is the most health-protective age range to evaluate, as children tend to have higher exposures than adults. The clearance standards will be equally applicable for any thirty year age range, *e.g.*, from age 20 to 50 years.

TCR	=	Target Cancer Risk (unitless)
THQ	=	Target Hazard Quotient (unitless)
AT	=	Averaging Time (years)
CSF _{derm}	=	Dermal Cancer Slope Factor (mg/kg-d) ⁻¹
RfD _{derm}	=	Dermal Reference Dose (mg/kg-d)
ABS _d	=	Dermal Absorption Fraction (unitless)
DF	=	Dermal Contact Factor (cm ² -yr/kg-d)
TC	=	Transfer Coefficient for hard (TC _h) or soft (TC _s) surfaces (cm ² /hour)
FTSS	=	Fraction Transferred from Surface to Skin for hard (FTSS _h) or soft (FTSS _s) surfaces (unitless)
ET	=	Exposure Time (hours/day)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)

Target Cancer Risk (TCR, unitless): US EPA established an "acceptable cancer risk range" of 1×10^{-6} to 1×10^{-4} (US EPA, 1990, 1991). US EPA recognizes that risks within this range are "generally acceptable" and those risks greater than 1×10^{-4} may be permitted depending on site-specific considerations. We used a target cancer risk of 10^{-6} , the TCR used by US EPA when developing the residential Regional Screening Levels (RSLs).

Target Hazard Quotient (THQ, unitless): US EPA notes a noncancer hazard quotient (HQ) or hazard index (HI) greater than 1 indicates further investigation is warranted (US EPA, 1989). We used a THQ of 1.

Averaging Time (AT, years): For noncancer hazards, the AT is equal to the exposure duration (5 years for the child and 25 years for the adult resident). For cancer risks, exposures are averaged over a 70-year (25,550 days) average lifetime consistent with US EPA guidance (US EPA, 2014). Although the current life expectancy for men and women in the United States is 78 years (US EPA, 2011), a value of 70 years was used, consistent with the value used to derive the toxicity factors.

Dermal Toxicity Values - Dermal Cancer Slope Factor (CSF_{derm}, (mg/kg-d)⁻¹) and Dermal Reference Dose (RfD_{derm}, mg/kg-d): There are no US EPA-derived toxicity values based specifically on toxicity studies involving dermal exposures. In the absence of dermal-specific CSFs or RfDs, oral toxicity factors are used, assuming that once a chemical is absorbed into the blood stream, the health effects are similar regardless of whether the route of exposure is oral or dermal. However, since oral toxicity criteria are based on the amount of a chemical *administered* per unit time and body weight (chemical intake), they were adjusted to be applicable to *absorbed* doses (dermal exposures are expressed as absorbed intake levels) (US EPA, 1989, 1992, 2004). Since most RfDs are based on studies where a chemical is administered in food or water, this adjustment is made using the oral absorption efficiency for that chemical. US EPA recommends adjusting the oral toxicity factor for use in evaluating dermal risks only when the oral absorption for that chemical is less than 50%, to "obviate the need to make comparatively small adjustments in the toxicity value that would otherwise impart on the process a level of accuracy that is not supported by the scientific literature" (US EPA, 2004). We used the oral toxicity values, which were used to calculate the US EPA RSLs (US EPA, 2017a). (The basis of the oral toxicity values used are discussed below under the HtM exposure pathway.) Hexavalent chromium was the only carcinogen for which an adjustment was needed to derive the dermal CSF; the dermal CSFs are the same as the oral CSFs for all other carcinogens. For noncancer effects, the adjustment was made for antimony, barium, cadmium, hexavalent chromium, manganese, nickel, and vanadium. For the other COPCs, the dermal RfDs are the same as the oral RfDs.

Dermal Absorption Fraction (ABS_d, unitless). The dermal absorption fraction represents the amount of a chemical in contact with skin that is absorbed through the skin and into the bloodstream. We obtained the dermal absorption values from US EPA's dermal risk assessment guidance (US EPA, 2004, Exhibit 3.4).

For arsenic, the dermal absorption fraction is 0.03; for cadmium, the dermal absorption fraction is 0.001; for PCBs, the dermal absorption fraction is 0.14, and for SVOCs, the dermal absorption fraction is 0.1 (Table 6). Dermal absorption values are not available for the other COPCs; therefore, we did not calculate CSL_{derm} for these constituents.

Dermal Contact Factor (DF, $\text{cm}^2\text{-yr/kg-day}$): The DF is the sum of the DFs calculated for each year of exposure and is calculated based on the equation above.

Transfer Coefficient (TC, cm^2/hour): The TC is the rate of skin contact with the surface. We used a TC of 1,200 cm^2/hour , the value used by US EPA (2003) for the WTC benchmarks. US EPA (2003) acknowledged that the TC varies by age but selected a TC value of 1200 cm^2/hr for all ages because it resulted in skin dust loads that were reasonably comparable to measured levels in indoor settings.

Exposure Time (ET, hours/day): US EPA used a default ET of 8 hours a day on soft surfaces (*i.e.*, carpet) and 4 hours a day on hard surfaces. Although US EPA (2003) adjusted these ETs for the WTC benchmarks to account for time spent outside the home (at school, for certain age groups), we conservatively applied US EPA's default values for all age groups, with no adjustment for time spent outside the home.

Fraction Transferred from Surface to Skin (FTSS, unitless): The FTSS varies based on the moisture on the skin surface, hand contact, and force of contact (US EPA, 2003). US EPA (2003) assumed an FTSS of 50% for hard surfaces and 10% for soft surfaces for their WTC benchmarks, based on a study that measured particle transfer on the hands (Rodes *et al.*, 2001, as cited in US EPA, 2003). However, dermal absorption of COPCs from dermal contact with surfaces is not limited to the hands. Residents may have exposure to dust on other parts of the body (*e.g.*, arms, legs, face) although the contact may be less intensive. Therefore, the FTSS was divided by two to represent an area weighted average for all exposed skin for dermal exposures, as US EPA did for the WTC benchmarks (US EPA, 2003).

Exposure Duration (ED, year): We assumed an ED of 1 year for each 1 year age group.

Body Weight (BW, kg): The mean BWs for each age year were used (US EPA, 2011, Table 8.3).

6.3.2 Dust Ingestion from Hand-to-Mouth (HtM) Contact

We calculated dust ingestion from HtM contact separately for cancer and noncancer endpoints using the following equations.

Cancer endpoints:

$$CSL_{\text{HtM}} = \frac{TCR \times AT}{(CSF \times IF)}$$

Noncancer endpoints:

$$CSL_{\text{HtM}} = \frac{THQ \times AT \times RfD}{IF}$$

where:

$$IF = \sum_{age} \frac{[(ET_{h-age} \times FTSS_h) + (ET_{s-age} \times FTSS_s)] \times SA_{H-age} \times FQ_{age} \times SE_{age} \times ED_{age}}{BW_{age}}$$

where:

CSL _{HtM}	=	Clearance Screening level for hand-to-mouth pathway (mg/cm ²)
TCR	=	Target Cancer Risk (unitless)
THQ	=	Target Hazard Quotient (unitless)
AT	=	Averaging Time (years)
CSF	=	Oral Cancer Slope Factor (mg/kg-d) ⁻¹
RfD	=	Oral Reference Dose (mg/kg-d)
IF	=	Intake Factor (cm ² -yr/kg-d)
ET	=	Exposure Time (hours/day)
FTSS	=	Fraction Transferred from Surface to Skin for hard (FTSS _h) or soft (FTSS _s) surfaces (unitless)
SA _H	=	Mouthed Surface Area of the Hand (cm ² /event)
FQ	=	Frequency of hand-to-mouth events (events/hour)
SE	=	Saliva Extraction Factor (unitless)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)

The parameters unique to this exposure pathway – oral toxicity values, Intake Factor (IF), Mouthed Surface Area of the Hand (SA_H), Frequency of hand-to-mouth events (FQ), and Saliva Extraction Factor (SE) – are discussed below. The values used for other parameters are the same as for the dermal contact pathway.

Oral Toxicity Values - Cancer Slope Factor (CSF (mg/kg-d)⁻¹) and Reference Dose (RfD, mg/kg-d): As previously stated, we used CSFs and RfDs summarized in the US EPA RSL Tables (US EPA, 2017a). The primary source of toxicity values is US EPA's IRIS. Toxicity values in IRIS undergo a rigorous peer review process and are generally considered to be of high quality. Additional toxicity values presented in the US EPA RSL Table (US EPA, 2017a) are from US EPA's Provisional Peer Reviewed Toxicity Values (PPRTV), US EPA's Health Effects Assessment Summary Table (HEAST), CalEPA, and Agency for Toxic Substances and Disease Registry (ATSDR). US EPA currently does not have a CSF for chromium VI, therefore, US EPA (2017a) relied on a CSF from NJDEP.

Intake Factor (IF, cm²-yr/kg-d): The IF is the sum of the IFs calculated for each year of exposure and is calculated based on the equation above.

Mouthed Surface Area of the Hand (SA_H, cm²/event): The mouthed surface area was assumed to be 5% of the surface area of both hands (US EPA, 2003). This is based on the assumption that three fingers of one hand are mouthed during each HtM event, and that three fingers represents 5% of the surface area of both hands. This assumption was used by US EPA in developing the WTC benchmarks (US EPA, 2003). The hand surface areas were obtained from US EPA's Exposure Factors Handbook (US EPA, 2011).

Frequency of HtM Events (FQ, events/hour): The frequency of hand-to-mouth activity decreases with age. We assumed an FQ of 9.5 times/hour for 1-6 year olds, 5 times/hour for 7-12 year olds, 2 times/hour for 8-18 year olds, and 1 time/hour for 19-31 year olds, based on the values used by US EPA (2003) for the WTC benchmarks.

Saliva Extraction Factor (SE, unitless): The amount of dust transferred from skin to mouth depends on the mouthing time and other behavioral patterns. We assumed that 50% of the dust on the mouthed portion of the hand is transferred to the mouth and swallowed, based on the value used by US EPA (2003) for the WTC benchmarks.

Table 5 presents the wipe clearance standards calculated for the 24 COPCs. (Table 6 presents the calculations for the wipe clearance standards.) The clearance standards are calculated as mg/cm² based on the units of the input parameters, and then converted to µg/m² for ease of use. Arsenic clearance standards were calculated based on both cancer and noncancer effects; they are 2.9 µg/m² based on cancer effects, and 175 µg/m² based on noncancer effects. We relied on the arsenic clearance standard based the noncancer endpoint, as was done by US EPA (2003). See further discussion about arsenic in Section 8 below.

6.4 Uncertainties

The methodology used to calculate the wipe clearance standards presented here incorporates multiple assumptions, which contribute inherent uncertainties that affect the final values. Uncertainties may exist in numerous areas, including opportunities for COPC dissipation, identity of measured surfaces, and exposure to multiple COPCs. We applied conservative values when applicable and available. Thus, most individuals will likely have lower exposures than assumed here. The most important contributors to uncertainty in this risk assessment are discussed below.

Dissipation: We conservatively assumed that the concentration of COPCs observed in the dust remains constant over time. We did not account for decreases in concentration (dissipation) over the 30-year period (e.g., due to chemical degradation, surface cleaning, or transfer). Thus, we conservatively assumed that the COPC concentration remains constant with each mouthing event.

Measured Surfaces: The clearance standards are based on exposure to the floor (i.e., bare or carpeted floor) thus they are very conservative when applied to wipe samples from walls, columns, and ceilings, because exposure to these other surfaces will likely be far less frequent than contact with the floor.

Multiple COPCs: The clearance standards were developed for each COPC individually, thus they do not account for exposure to multiple COPCs at the same time. However, we used a conservative TCR of 10⁻⁶. In addition, for noncancer, the target organs and critical effects differ for the various COPCs.

Regardless of the uncertainties described above, the wipe clearance standards will be health protective for residential use of the buildings.

7 Bulk Dust Clearance Standards

Bulk dust clearance standards were calculated for all COPCs, except for PCBs. Clearance standards for bulk dust were based on the US EPA Regional Screening Levels (RSLs) for residential soil. The RSLs used for the bulk clearance standards were those with noncancer hazard calculated with a target hazard quotient (HQ) of 1, and cancer risk calculated with a target risk of 1 x 10⁻⁶ (US EPA, 2017b). US EPA assumptions concerning exposure to outdoor soil and indoor dust are equivalent, thus it is appropriate to use the residential soil RSLs as clearance standards for bulk samples of indoor dust. The TSCA standards were used for PCBs. TSCA has established bulk standards⁴ for PCBs of 1 mg/kg for high occupancy areas, and 25 mg/kg for low occupancy areas (US EPA, 2016).

Table 7 presents the bulk dust clearance standards for the 24 COPCs. The Wisconsin Department of Natural Resources (WDNR) Non-Industrial Soil Residual Contaminant Levels (RCLs) are also presented in this table for comparison purposes; they are calculated using US EPA's RSL calculator and WDNR guidance (WDNR, 2017). The WDNR RCLs differ slightly from US EPA's RSLs in that they are calculated with air

⁴ The bulk standards apply to "bulk PCB remediation waste" (US EPA, 2016).

dispersion factors that are specific to the Midwest. The criteria are the essentially the same for majority of the analytes, with the WI RCLs generally within a factor of 1.4 of the US EPA RSLs.

Arsenic bulk dust clearance standards were calculated based on both cancer and noncancer effects; they are 0.68 mg/kg based on cancer effects, and 35 mg/kg based on noncancer effects. We relied on the arsenic clearance standard based on the noncancer endpoint. See further discussion about arsenic in Section 8 below.

The current lead standard of 400 mg/kg is based on a target BLL of 10 µg/dL for children. In 2012, the Centers for Disease Control (CDC) changed the child BLL of concern from 10 µg/dL to a reference value of 5 µg/dL. US EPA is expected to lower the target BLL to the CDC reference value of 5 µg/dL in the near future, and this change is expected to result in a new lead RSL of about 200 mg/kg. Gradient notes that if this change occurs before the building redevelopment is completed, it may be prudent to use the revised lead RSL in place of the one recommended here.

8 Special Considerations for Arsenic

Arsenic, like many metals, occurs naturally in soil and is present in airborne dust (ATSDR, 2007). The US EPA soil RSL for arsenic of 0.68 mg/kg is lower than typical naturally occurring background levels, and thus background must be considered in establishing clearance standards for arsenic in dust. Natural levels of arsenic in soil were evaluated using data from a study by the US Geological Survey, which analyzed arsenic in surface soils (0-5 cm) at 88 locations in Wisconsin (USGS, 2013). The naturally occurring arsenic concentration in WI soil ranged from 1.1-52.3 mg/kg, with an average concentration of 4.1 mg/kg. In addition, the Wisconsin soil arsenic background threshold value is 8 mg/kg (WDNR, 2017). The arsenic concentrations in the building material samples ranged from 0.84-160 mg/kg, with the majority (88%) within the range of natural soil background for WI. For the 22 (of 25) samples with arsenic below 52 mg/kg, the average arsenic concentration was 7.4 mg/kg. Thus, arsenic concentrations in degraded building materials may be indistinguishable from arsenic concentrations in dust with a source in naturally occurring soil. Since the lower criteria of 2.9 µg/m² for wipe samples and 0.68 mg/kg for bulk dust samples may be unachievable, and/or may result in the remediation of background arsenic concentrations, we relied on the clearance standard for noncancer endpoints (175 µg/m² for wipe samples and 35 mg/kg for bulk dust samples).

Although US EPA does not explicitly state the reason that their arsenic benchmarks developed in the WTC analysis were based on the noncancer endpoint, they note that their remediation goals were influenced by analytical technical implementation, analytical detection limits, and background concentration (US EPA, 2003). For example, the standard of 2.9 µg/m² (0.27 µg/ft²) is lower than the maximum detection limit (1.3 µg/ft²) from the post-cleaning data from the pilot test conducted by Key Engineering.

9 Conclusions

The property at 300 South Barclay Street and 139 East Oregon Street includes several former industrial buildings that will be redeveloped for residential use. Gradient developed dust clearance standards for wipe samples and bulk dust that will be used in determining whether building surfaces are sufficiently clean for residential use, after cleaning, sealing, or encapsulation of interior building surfaces. Gradient conducted a screening analysis to determine the COPCs for which interior dust clearance standards would be developed. A total of 24 analytes were retained as COPCs, including 15 metals, cyanide, 2 PCBs, and 6 SVOCs, and interior dust clearance standards were developed for this list of COPCs. Gradient also evaluated the non-detected analytes based on their detection limit, and concluded that no additional analytes

need to be included as COPCs. Dust clearance standards were not developed for VOCs because none exceeded the screening criteria, however, a total of 21 VOCs were detected in the building material samples. Since residents could have exposure to VOCs *via* the inhalation pathway, it is our understanding that a separate plan will be developed to determine the extent to which potential off-gassing of VOCs from building materials is occurring.

Gradient developed two types of clearance standards for use in assessing interior dust samples that may contain degraded building materials; one for COPCs in surface dust loading (in $\mu\text{g}/\text{m}^2$) for use with wipe samples, and one for COPCs in bulk dust (in mg/kg). The wipe clearance standards account for two pathways of exposure to dust on indoor surfaces: dermal absorption through the skin, and incidental ingestion of dust from hand-to-mouth contact. Post-remedy dust data will be compared with these health-based clearance standards to determine if cleaning and sealing of building surfaces at the Barclay Street Property is adequately protective for future residential use. Surfaces, or bulk dust samples, with concentrations below their respective clearance standard indicate that concentrations in the sampled dust are not anticipated to pose adverse health effects for future residents who may contact these surfaces.

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Tables

Table 1 COPCs and Maximum Exceedance Ratios

Group	Analyte	Building Surface	11	11	11	11	33	33	33	33	34	34	34	34	34	Max. Ratio	Count
			Brick Wall	Concrete Column	Concrete Floor	Concrete Wall	Brick Wall	Concrete Floor	Terracotta Tile Ceiling	Wood Ceiling	Brick Wall	Concrete Column	Concrete Floor	Concrete Wall	Terracotta Tile Ceiling		
			N = 2	N = 5	N = 4	N = 1	N = 2	N = 1	N = 1	N = 2	N = 1	N = 2	N = 2	N = 1	N = 1		
METALS	Aluminum		2	1	1	1	2		5			1	1		5	5	9
METALS	Antimony			4												4	1
METALS	Arsenic		235	71	143	22	8	2	9	1		3	4	5	16	235	12
METALS	Barium								1							1.2	1
METALS	Cadmium		20	6												20	2
METALS	Chromium, Hexavalent		1100	187	1000	33	31	16	2			33	37	97		1100	10
METALS	Cobalt		3	2	1	1	2	2	4			15	4	11	17	17	11
METALS	Copper		2	2	5	1	5	1				3	2	3		5	9
METALS	Cyanide, Total		1		4		1									4	3
METALS	Iron		1	2	1	2	1	1	3			2	2	1	3	3	11
METALS	Lead		2				2									2	2
METALS	Manganese		1	8	9	7			2			1	1	1	1	9	9
METALS	Mercury				2		2									2	2
METALS	Nickel				2		2					1		1		2	4
METALS	Vanadium								2						2	2	2
METALS	Zinc		1				9			2			5			9	4
PCB	PCB-1254		11667	5333	1417		2		3	2		3	6	1	3	11667	10
PCB	PCB-1260						1		1							1.2	2
SVOC	Benzaldehyde				1					2						2	2
SVOC	Benzyl Alcohol				7											7	1
SVOC	Bis(2-chloroethyl)ether									100						100	1
SVOC	Bis(2-ethylhexyl) Phthalate												10			10	1
SVOC	Butyl Benzyl Phthalate												3			3	1
SVOC	N-Nitrosodi-n-propylamine				7											7	1
COPC:			12	10	14	7	13	5	10	5	0	9	11	8	7	24	

Notes:

CalEPA = California Environmental Protection Agency; COPC = Compound of Potential Concern; PCB = Polychlorinated Biphenyl; RSL = Regional Screening Level; SVOC = Semivolatile Organic Compound.

Based on June 2017 RSLs for Residential Soils (HQ = 0.1).

Only analytes that are detected with at least one RSL exceedance are presented.

Detected analytes without an RSL: titanium and total chromium. Total chromium evaluated as trivalent and hexavalent chromium. The CalEPA screening level was used for titanium.

Table 2 Method Detection Limit Exceedances

Group	Analyte	Number of Detects	Max. MDL	Detected Exceedances		MDL Exceedances		COPC
				RSL HQ 0.1	RSL HQ 1	RSL HQ 0.1	RSL HQ 1	
METALS	Chromium, hexavalent	19	3.5	19	19	6	6	C
METALS	Thallium	0	0.43			25	0	
PCB	PCB-1016	0	63			8	5	
PCB	PCB-1221	0	79			9	9	
PCB	PCB-1232	0	78			10	10	
PCB	PCB-1242	0	59			9	9	
PCB	PCB-1248	0	71			9	9	
PCB	PCB-1254	16	2	14	11	2	1	C
PCB	PCB-1260	2	88	2	2	9	9	C
SVOC	1,4-Dioxane	0	10			2	2	
SVOC	2,4-Dinitrophenol	0	18			1	0	
SVOC	2,6-Dinitrotoluene	0	2.1			4	4	
SVOC	3,3'-Dichlorobenzidine	0	1.5			1	1	
SVOC	4,6-Dinitro-2-methylphenol	0	8.4			14	2	
SVOC	4-Chloroaniline	0	4.9			2	2	
SVOC	Atrazine	0	3.1			1	1	
SVOC	Benzo[a]pyrene	1	0.2	0	0	2	2	
SVOC	Bis(2-chloroethyl)ether	1	0.98	1	1	10	10	C
SVOC	Dibenz(a,h)anthracene	0	0.2			2	2	
SVOC	Hexachlorobenzene	1	0.24	0	0	1	1	
SVOC	Hexachlorobutadiene	0	1.6			1	1	
SVOC	Hexachlorocyclopentadiene	0	6			24	4	
SVOC	N-Nitrosodi-n-propylamine	1	1.3	1	1	13	13	C
SVOC	Pentachlorophenol	0	17			14	14	
VOC	1,1,2,2-Tetrachloroethane	0	0.64			1	1	
VOC	1,1,2-Trichloroethane	0	0.56			1	0	
VOC	1,2,3-Trichloropropane	0	0.66			25	25	
VOC	1,2-Dibromo-3-Chloropropane	0	3.2			25	25	
VOC	1,2-Dibromoethane	0	0.62			6	6	
VOC	1,2-Dichloroethane	0	0.63			1	1	
VOC	1,2-Dichloropropane	0	0.69			1	1	
VOC	Bromodichloromethane	0	0.6			1	1	
VOC	Bromomethane	1	1.3	0	0	1	0	
VOC	Chloroform	0	0.59			1	1	
VOC	Vinyl Chloride	0	0.42			1	1	
Count		35						
Detected		8						
Not Detected		27						

Notes:

C = Compound is already a COPC based on detected concentrations.

COPC = Compound of Potential Concern; HQ = Hazard Quotient; MDL = Method Detection Limit; PCB = Polychlorinated Biphenyl; RSL = Regional Screening Level; SVOC = Semivolatile Organic Compound; VOC = Volatile Organic Compound.

Orange shading = Compound has detected concentrations.

RSL HQ 0.1 = June 2017 RSLs based on an HQ of 0.1 for Residential Soils.

RSL HQ 1 = June 2017 RSLs based on an HQ of 0.1 for Residential Soils.

Table 3 Number of Samples with Detected VOC, by Building/Surface

Group	Analyte	Building Surface		11	11	11	11	33	33	33	33	34	34	34	34	Location Count	Sum of Detects
		Brick Wall	Concrete Column	Concrete Floor	Concrete Wall	Brick Wall	Concrete Floor	Terracotta Tile Ceiling	Wood Ceiling	Brick Wall	Concrete Column	Concrete Floor	Terracotta Tile Ceiling	Location Count	Sum of Detects		
		N = 2	N = 5	N = 4	N = 1	N = 2	N = 1	N = 1	N = 2	N = 1	N = 2	N = 2	N = 1				
VOC	1,2,4-Trimethylbenzene			1		2	1	1	2					5	7		
VOC	1,3,5-Trimethylbenzene					2	1							2	3		
VOC	2-Butanone (MEK)								2					1	2		
VOC	4-Methyl-2-pentanone (MIBK)					1			2					2	3		
VOC	Acetone			2		2			2					3	6		
VOC	Benzene			1					2					2	3		
VOC	Bromomethane								1					1	1		
VOC	Chloromethane	1		1										2	2		
VOC	Ethylbenzene			1		2	1	1	2					5	7		
VOC	Isopropylbenzene					1	1	1						3	3		
VOC	m&p-Xylene								2					1	2		
VOC	Methyl Acetate	1	4	4	1	2	1	1	2	1	2	2	1	12	22		
VOC	Methylene Chloride								2					1	2		
VOC	Naphthalene		3	2		1	1	1	2	1	1			8	12		
VOC	N-Propylbenzene								1					1	1		
VOC	o-Xylene								2					1	2		
VOC	sec-Butylbenzene					1								1	1		
VOC	Styrene			1				1						2	2		
VOC	tert-Butylbenzene								2					1	2		
VOC	Toluene		1	1		2	1	1	2	1	1	1		9	11		
VOC	Xylenes, Total		2	1		2	1	1	2	1	1	1	1	10	13		
Count		2	4	10	1	11	8	8	16	4	4	3	2	21			

Note:

VOC = Volatile Organic Compound.

Table 4 Maximum Detect VOC Concentrations by Building/Surface

Group	Analyte	Building Surface	11 Brick Wall N = 2	11 Concrete Column N = 5	11 Concrete Floor N = 4	11 Concrete Wall N = 1	33 Brick Wall N = 2	33 Concrete Floor N = 1	33 Terracotta Tile Ceiling N = 1	33 Wood Ceiling N = 2	34 Brick Wall N = 1	34 Concrete Column N = 2	34 Concrete Floor N = 2	34 Terracotta Tile Ceiling N = 1	Max. Conc.	Count
VOC	1,2,4-Trimethylbenzene				0.92		0.60	0.17	0.30	0.30					0.92	5
VOC	1,3,5-Trimethylbenzene						0.32	0.060							0.32	2
VOC	2-Butanone (MEK)									2.3					2.3	1
VOC	4-Methyl-2-pentanone (MIBK)						1.4			0.55					1.4	2
VOC	Acetone				5.9		0.51			2.5					5.9	3
VOC	Benzene				0.14					0.16					0.16	2
VOC	Bromomethane									0.14					0.14	1
VOC	Chloromethane		0.064		0.12										0.12	2
VOC	Ethylbenzene				0.13		0.026	2.2	4.2	0.069					4.2	5
VOC	Isopropylbenzene						0.052	1.4	2.7						2.7	3
VOC	m&p-Xylene									0.81					0.81	1
VOC	Methyl Acetate		1.7	2400	17	1.3	21	1.8	3.6	0.20	1.5	2.5	5.2	1.5	2400	12
VOC	Methylene Chloride									2.0					2.0	1
VOC	Naphthalene			0.18	1.5		0.11	0.28	0.47	1.2	3.4	0.097			3.4	8
VOC	N-Propylbenzene									0.030					0.030	1
VOC	o-Xylene									0.20					0.20	1
VOC	sec-Butylbenzene						0.081								0.081	1
VOC	Styrene				0.071				0.85						0.85	2
VOC	tert-Butylbenzene									2.9					2.9	1
VOC	Toluene			0.017	2.9		0.095	0.054	0.10	6.8	0.093	0.23	0.11		6.8	9
VOC	Xylenes, Total			0.088	0.47		0.37	25	50	0.97	0.020	0.18	0.036	0.034	50	10
Count =			2	4	10	1	11	8	8	16	4	4	3	2	21	21

Notes:

VOC = Volatile Organic Compound.

All concentrations reported in mg/kg.

Table 5 Clearance Standards for Wipe Samples

Group	COPC	Clearance Standard	
		(mg/cm ²)	(µg/m ²)
METALS	Aluminum	7.2E-02	719,305
METALS	Antimony	2.9E-05	288
METALS	Arsenic - Cancer	2.9E-07	2.9
METALS	Arsenic - Noncancer	1.8E-05	175 ^a
METALS	Barium	1.4E-02	143,861
METALS	Cadmium	5.5E-05	549
METALS	Chromium VI	1.1E-06	11
METALS	Cobalt	2.2E-05	216
METALS	Copper	2.9E-03	28,772
METALS	Cyanide	4.3E-05	432
METALS	Iron	5.0E-02	503,513
METALS	Lead	4.3E-05	431
METALS	Manganese	1.7E-03	17,263
METALS	Mercury	7.2E-06	72
METALS	Nickel	1.4E-03	14,386
METALS	Vanadium	3.6E-04	3,597
METALS	Zinc	2.2E-02	215,791
PCB	PCB-1254	NA	NA ^b
PCB	PCB-1260	NA	NA ^b
PCB	PCB Total, High Occupancy	1.0E-04	1,000 ^b
PCB	PCB Total, Low Occupancy	1.0E-03	10,000 ^b
SVOC	Benzaldehyde	7.0E-05	696
SVOC	Benzyl Alcohol	4.0E-03	40,480
SVOC	Bis(2-chloroethyl)ether	2.5E-07	2.5
SVOC	Bis(2-ethylhexyl) Phthalate	2.0E-05	199
SVOC	Butyl Benzyl Phthalate	1.5E-04	1,465
SVOC	N-Nitrosodi-n-propylamine	4.0E-08	0.4

Notes:

COPC = Compound of Potential Concern; NA = Not Applicable; PCB = Polychlorinated Biphenyl;
SVOC = Semivolatile Organic Compound.

(a) Recommended standard for arsenic.

(b) PCB standards listed in 40 CFR Part 761, for non-porous surfaces, as 10 µg/100 cm² for high occupancy areas, and 100 µg/100 cm² for low occupancy areas.

Table 6 Wipe Clearance Standard Calculation

Chemical Group	COPC	Toxicity Values				Dermal Absorption Factor (unitless)	Contaminant Surface Load (mg/cm ²) - Dermal			Contaminant Surface Load (mg/cm ²) - HTM			Clearance Standard (mg/cm ²) (Combined Dermal + HTM)			Clearance Standard (min. of all 3 options)	
		Cancer Slope Factor (CSF) (mg/kg-d) ⁻¹	Dermal Cancer Slope Factor (CSF _{derm}) (mg/kg-d) ⁻¹	Reference Dose (RfD) (mg/kg-d)	Dermal Reference Dose (RfD _{derm}) (mg/kg-d)		Based on TCR	Based on THQ - Child	Based on THQ - Adult	Based on TCR	Based on THQ - Child	Based on THQ - Adult	Based on TCR	Based on THQ - Child	Based on THQ - Adult	(mg/cm ²)	(µg/m ²)
METALS	Aluminum	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	NA	7.2E-02	4.6E-01	NA	7.2E-02	4.6E-01	7.2E-02	719,305
METALS	Antimony	NA	NA	4.0E-04	6.0E-05	NA	NA	NA	NA	NA	2.9E-05	1.9E-04	NA	2.9E-05	1.9E-04	2.9E-05	288
METALS	Arsenic	1.5E+00	1.5E+00	3.0E-04	3.0E-04	3.0E-02	1.2E-06	9.3E-05	3.4E-04	3.8E-07	2.2E-05	1.4E-04	2.9E-07	1.8E-05	9.9E-05	2.9E-07	2.9
METALS	Arsenic - Noncancer only	NA	NA	3.0E-04	3.0E-04	3.0E-02	NA	9.3E-05	3.4E-04	NA	2.2E-05	1.4E-04	NA	1.8E-05	9.9E-05	1.8E-05	175
METALS	Barium	NA	NA	2.0E-01	1.4E-02	NA	NA	NA	NA	NA	1.4E-02	9.3E-02	NA	1.4E-02	9.3E-02	1.4E-02	143,861
METALS	Cadmium	NA	NA	1.0E-03	2.5E-05	1.0E-03	NA	2.3E-04	8.4E-04	NA	7.2E-05	4.6E-04	NA	5.5E-05	3.0E-04	5.5E-05	549
METALS	Chromium VI	5.0E-01	2.0E+01	3.0E-03	7.5E-05	NA	NA	NA	NA	1.1E-06	2.2E-04	1.4E-03	1.1E-06	2.2E-04	1.4E-03	1.1E-06	11
METALS	Cobalt	NA	NA	3.0E-04	3.0E-04	NA	NA	NA	NA	NA	2.2E-05	1.4E-04	NA	2.2E-05	1.4E-04	2.2E-05	216
METALS	Copper	NA	NA	4.0E-02	4.0E-02	NA	NA	NA	NA	NA	2.9E-03	1.9E-02	NA	2.9E-03	1.9E-02	2.9E-03	28,772
METALS	Cyanide	NA	NA	6.0E-04	6.0E-04	NA	NA	NA	NA	NA	4.3E-05	2.8E-04	NA	4.3E-05	2.8E-04	4.3E-05	432
METALS	Iron	NA	NA	7.0E-01	7.0E-01	NA	NA	NA	NA	NA	5.0E-02	3.3E-01	NA	5.0E-02	3.3E-01	5.0E-02	503,513
METALS	Lead ^a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.3E-05	431
METALS	Manganese	NA	NA	2.4E-02	9.6E-04	NA	NA	NA	NA	NA	1.7E-03	1.1E-02	NA	1.7E-03	1.1E-02	1.7E-03	17,263
METALS	Mercury	NA	NA	1.0E-04	1.0E-04	NA	NA	NA	NA	NA	7.2E-06	4.6E-05	NA	7.2E-06	4.6E-05	7.2E-06	72
METALS	Nickel	NA	NA	2.0E-02	8.0E-04	NA	NA	NA	NA	NA	1.4E-03	9.3E-03	NA	1.4E-03	9.3E-03	1.4E-03	14,386
METALS	Vanadium	NA	NA	5.0E-03	1.3E-04	NA	NA	NA	NA	NA	3.6E-04	2.3E-03	NA	3.6E-04	2.3E-03	3.6E-04	3,597
METALS	Zinc	NA	NA	3.0E-01	3.0E-01	NA	NA	NA	NA	NA	2.2E-02	1.4E-01	NA	2.2E-02	1.4E-01	2.2E-02	215,791
PCB	PCB-1254	NA	NA	2.0E-05	2.0E-05	1.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCB	PCB-1260	NA	NA	NA	NA	1.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SVOC	Benzaldehyde	4.0E-03	4.0E-03	1.0E-01	1.0E-01	1.0E-01	1.4E-04	9.3E-03	3.4E-02	1.4E-04	7.2E-03	4.6E-02	7.0E-05	4.0E-03	2.0E-02	7.0E-05	696
SVOC	Benzyl alcohol	NA	NA	1.0E-01	1.0E-01	1.0E-01	NA	9.3E-03	3.4E-02	NA	7.2E-03	4.6E-02	NA	4.0E-03	2.0E-02	4.0E-03	40,480
SVOC	Bis(2-chloroethyl)ether	1.1E+00	1.1E+00	NA	NA	1.0E-01	5.0E-07	NA	NA	5.2E-07	NA	NA	2.5E-07	NA	NA	2.5E-07	2.5
SVOC	Bis(2-ethylhexyl) phthalate	1.4E-02	1.4E-02	2.0E-02	2.0E-02	1.0E-01	3.9E-05	1.9E-03	6.7E-03	4.1E-05	1.4E-03	9.3E-03	2.0E-05	8.1E-04	3.9E-03	2.0E-05	199
SVOC	Butyl Benzyl Phthalate	1.9E-03	1.9E-03	2.0E-01	2.0E-01	1.0E-01	2.9E-04	1.9E-02	6.7E-02	3.0E-04	1.4E-02	9.3E-02	1.5E-04	8.1E-03	3.9E-02	1.5E-04	1,465
SVOC	N-Nitrosodi-n-propylamine	7.0E+00	7.0E+00	NA	NA	1.0E-01	7.8E-08	NA	NA	8.1E-08	NA	NA	4.0E-08	NA	NA	4.0E-08	0.4

Notes:

COPC = Chemical of Potential Concern; HTM = Hand-to-Mouth Pathway; NA = Not Applicable; PCB = Polychlorinated Biphenyl; SVOC = Semivolatile Organic Compound; TCR = Target Cancer Risk; THQ = Target Hazard Quotient.

Clearance Standard Calculation

Clearance Standard =

$$\frac{1}{\text{CSL}_{\text{derm}}} + \frac{1}{\text{CSL}_{\text{HTM}}}$$

a) Clearance Standard for lead from US EPA (2001).

$$\begin{aligned} &40 \text{ µg/ft}^2 \\ &4.3\text{E-}05 \text{ mg/cm}^2 \\ &1\text{ft}^2 = 929 \text{ cm}^2 \\ &1 \text{ µg} = 0.001 \text{ mg} \end{aligned}$$

Contaminant Surface Load (CSL) Calculations - Cancer

$$\text{CSL}_{\text{derm}} = \text{TCR} \times \text{AT} / (\text{CSF}_{\text{derm}} \times \text{ABS} \times \text{DF}_5)$$

$$\text{CSL}_{\text{HTM}} = \text{TCR} \times \text{AT} / (\text{CSF} \times \text{IF}_5)$$

$$\text{DF}_5 = \Sigma [(\text{TC}_{\text{age}} \times \text{ET}_{\text{h age}} \times \text{FTSS}_{\text{h age}}/2) + (\text{TC}_{\text{age}} \times \text{ET}_{\text{s age}} \times \text{FTSS}_{\text{s age}}/2)] \times \text{ED}_{\text{age}} / \text{BW}_{\text{age}}$$

$$\text{IF}_5 = \Sigma [(\text{ET}_{\text{h child}} \times \text{FTSS}_{\text{h child}}) + (\text{ET}_{\text{s child}} \times \text{FTSS}_{\text{s child}})] \times \text{SA}_{\text{H child}} \times \text{FQ}_{\text{child}} \times \text{SE}_{\text{child}} \times \text{ED}_{\text{child}} / \text{BW}_{\text{child}}$$

CSL Calculations - Noncancer

$$\text{CSL}_{\text{derm}} = \text{THQ} \times \text{AT} \times \text{RfD}_{\text{derm}} / \text{DF}_5 \times \text{ABS}$$

$$\text{CSL}_{\text{HTM}} = \text{THQ} \times \text{AT} \times \text{RfD} / \text{IF}_5$$

Orange shading = US EPA RSLs do not provide a dermal absorption factor for these SVOCs. We used US EPA's recommended absorption of 10% for SVOCs (US EPA, 2004).

Parameter	Acronym	Value	Basis
Target Cancer Risk (unitless)	TCR	1E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Surface Area of Hands (cm ²)	SA	Age Spec.	US EPA, 2011, Table 7-2
Surface Area of Hand in Mouth (cm ² /event)	SA _H	5%	5% of SA of both hands (US EPA, 2003)
Saliva Extraction Factor (unitless)	SE	0.5	US EPA, 2003
Fraction Transferred from Surface to Skin - Hard (unitless)	FTSS-h	0.5	US EPA, 2003
Fraction Transferred from Surface to Skin - Soft (unitless)	FTSS-s	0.1	US EPA, 2003
Indoor Surface Transferable Residue (mg/cm ²)	ISR	Chem. Spec.	Calculated
Frequency of Hand to Mouth Events (event/hr)	FQ	Age Spec.	US EPA, 2003
Transfer Coefficient (cm ² /hr)	TC	1,200	US EPA, 2003
Exposure Time (hr/d) - Hard	ET-h	4	Prof Judgment using US EPA, 2003
Exposure Time (hr/d) - soft	ET-S	8	Prof Judgment using US EPA, 2003
Body Weight (kg)	BW	Age Spec.	US EPA, 2011, Table 8-1
Dermal Contact Factor - Age Adjusted (cm ² -yr/kg-d)	DF _s	Chem. Spec.	Calculated
Ingestion Factor - Age adjusted (cm ² -yr/kg-d)	IF _s	Chem. Spec.	Calculated
Averaging Time - Cancer (yr)	AT-C	70	
Averaging Time - Noncancer - child (yr)	AT-NCc	5	
Averaging Time - Noncancer - adult (yr)	AT-NCa	25	

Age Specific Parameters

Age	Exposure Parameters												
	SA Both Hands (m ²)	SA _H (m ²)	SA _H (cm ² /event)	FQ (ev/hr)	SE (unitless)	ET-H (hr/d)	ET-S (hr/d)	TC (cm ² /hr)	BW (kg)	FTSS-h (unitless)	FTSS-s (unitless)	DF ₅ (cm ² -yr/kg-d)	IF ₅ (cm ² -yr/kg-d)
1*	0.028	0.0014	14.0	9.5	0.5	4	8	1200	11.4	0.5	0.1	147.4	16.3
2	0.028	0.0014	14.0	9.5	0.5	4	8	1200	13.8	0.5	0.1	121.7	13.5
3	0.037	0.00185	18.5	9.5	0.5	4	8	1200	18.6	0.5	0.1	90.3	13.2
4	0.037	0.00185	18.5	9.5	0.5	4	8	1200	18.6	0.5	0.1	90.3	13.2
5	0.037	0.00185	18.5	9.5	0.5	4	8	1200	18.6	0.5	0.1	90.3	13.2
6	0.051	0.00255	25.5	5	0.5	4	8	1200	31.8	0.5	0.1	52.8	5.6
7	0.051	0.00255	25.5	5	0.5	4	8	1200	31.8	0.5	0.1	52.8	5.6
8	0.051	0.00255	25.5	5	0.5	4	8	1200	31.8	0.5	0.1	52.8	5.6
9	0.051	0.00255	25.5	5	0.5	4	8	1200	31.8	0.5	0.1	52.8	5.6
10	0.051	0.00255	25.5	5	0.5	4	8	1200	31.8	0.5	0.1	52.8	5.6
11	0.072	0.0036	36	5	0.5	4	8	1200	56.8	0.5	0.1	29.6	4.4
12	0.072	0.0036	36	2	0.5	4	8	1200	56.8	0.5	0.1	29.6	1.8
13	0.072	0.0036	36	2	0.5	4	8	1200	56.8	0.5	0.1	29.6	1.8
14	0.072	0.0036	36	2	0.5	4	8	1200	56.8	0.5	0.1	29.6	1.8
15	0.072	0.0036	36	2	0.5	4	8	1200	56.8	0.5	0.1	29.6	1.8
16	0.083	0.00415	41.5	2	0.5	4	8	1200	71.6	0.5	0.1	23.5	1.6
17	0.083	0.00415	41.5	2	0.5	4	8	1200	71.6	0.5	0.1	23.5	1.6
18	0.083	0.00415	41.5	1	0.5	4	8	1200	71.6	0.5	0.1	23.5	0.8
19	0.083	0.00415	41.5	1	0.5	4	8	1200	71.6	0.5	0.1	23.5	0.8
20	0.083	0.00415	41.5	1	0.5	4	8	1200	71.6	0.5	0.1	23.5	0.8
21	0.083	0.00415	41.5	1	0.5	4	8	1200	71.6	0.5	0.1	23.5	0.8
22	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
23	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
24	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
25	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
26	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
27	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
28	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
29	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9
30	0.098	0.0049	49	1	0.5	4	8	1200	80	0.5	0.1	21.0	0.9

Notes:

* Surface area for 1 year old assumed to be the same as the 2 year old, due to lack of data for 1 year old. Child defined as age 1 to 6 yr, as in US EPA (2003).

CSLs differ from values used by US EPA (2003) because 1) dissipation was not included here; and 2) updated exposure assumptions were used from 2011 Exposure Factors Handbook, which report SA_H and BW in age groups.

Table 7 Clearance Standards for Bulk Samples

Group	Analyte	Clearance Standard (mg/kg)	WDNR RCL (mg/kg)
METALS	Aluminum	77,000	77500
METALS	Antimony	31	31
METALS	Arsenic - Cancer	0.68	0.68
METALS	Arsenic - Noncancer	35 ^a	35
METALS	Barium	15,000	15300
METALS	Cadmium	71	71
METALS	Chromium, hexavalent	0.3	0.30
METALS	Cobalt	23	23
METALS	Copper	3,100	3130
METALS	Cyanide, Total	23	27
METALS	Iron	55,000	54800
METALS	Lead	400	400
METALS	Manganese	1,800	1830
METALS	Mercury	11	3.1 ^c
METALS	Nickel	1,500	1550
METALS	Vanadium	390	393
METALS	Zinc	23,000	23500
PCB	PCB-1254	NA	0.24
PCB	PCB-1260	NA	0.24
PCB	PCB Total, High Occupancy	1 ^b	
PCB	PCB Total, Low Occupancy	25 ^b	
SVOC	Benzaldehyde	170	174
SVOC	Benzyl Alcohol	6,300	6320
SVOC	Bis(2-chloroethyl)ether	0.23	0.29
SVOC	Bis(2-ethylhexyl) Phthalate	39	39
SVOC	Butyl Benzyl Phthalate	290	286
SVOC	N-Nitrosodi-n-propylamine	0.078	0.078

Notes:

NA = Not Applicable; PCB = Polychlorinated Biphenyl; SVOC = Semivolatile Organic Compound; WDNR RCL = Wisconsin Department of Natural Resources (DNR) Soil Residual Contaminant Level.

(a) Recommended standard for arsenic.

(b) PCB standards obtained from 40 CFR Part 761.

(c) WI RCL for elemental mercury is based on soil saturation concentration, which would not be applicable to dust.